

a considerable amount of patience, Mr. J. M. Pernter has calculated the tints and the angular deviations of the rainbow colours for various sizes of rain-drops, and has devised experiments in support of his deductions. A parallel beam of sunlight after reflection and refraction in a spherical rain-drop does not emerge as a parallel beam, or as a bunch of parallel beams of various colours, but as a series of caustics of a somewhat complicated nature, in which the divergence of the colours, and hence their distinctness, separation, or coincidence depend upon the ratio of the radius of the drop to the wave-length of the light. The influence of size is very formidable in the smaller drops, say of 0.01 mm. radius. This would be a very fine spray. The actual size of rain-drops is supposed to vary between 0.1 mm. and 2.6 mm., but the heavy drops of tropical rains are said to attain diameters of 3.4 mm. Their size may be estimated by catching up and weighing a definite number, or by the more difficult method of diffraction. The tables drawn up by Pernter consider drops of twelve different sizes between 0.005 and 1 mm. radius. In order to determine the resulting colours, Pernter selects eight of Maxwell's twenty-two colour equations, which number he finds sufficiently accurate. The first set of his tables state, for a point source of light, the sequence of colours, their composition in terms of red, green, and violet, the relative intensity (admixture of white, after Abney) and position on the colour triangle of each shade for various deviations between $42^{\circ}20'$ and 36° . These tables are then verified by experiments with cylindrical streams of drops, according to Babinet's method. With 1 mm. drops, Pernter observed red, orange-yellow, green, violet, blue, second violet, and then twenty-four secondaries or spurious colours, chiefly pinkish-violet and green or blue; after the twelfth violet came a whitish band, and then a reversal in the sequence of the colours. The 0.5 mm. drops gave 11 bows with 40 shades. The outer bow and its secondaries were also observed. Verifications in nature are hardly possible, as we cannot measure simultaneously the angles and the size of the drops producing the bow; it is striking, however, that so very few angular measures are extant.

The white or pale rainbows (fog or mist bows) around moon and sun may appear pale owing to (1) the feeble intensity of the light, (2) the uneven size of the drops, and (3) the mixture of colours. The first cause is probably a real one; the second Pernter is inclined to reject, since the accompanying, often well-defined features such as "glories," Brocken spectra, &c., and also his own tests require homogeneous conditions. As regards the third, Abney has proved that all colours of any shade disappear on being diluted with 75 parts of white, and Pernter's tables show that such cases may well occur. Further, Airy's theory renders white bands possible for all sizes of drops, and necessary for radii below 25μ . As a stream of water of such fineness cannot be maintained, Pernter produced a mist spray by fixing a 0.5 mm. glass tube in a lead pipe connected with the Innsbruck water mains (pressure 5 atmospheres), and directing the jet against a metallic plate; the size of drops was derived from measurements of diffraction rings. Drops of radius 5μ gave a yellow margin at $41^{\circ}59'$, white between $41^{\circ}8'$ and $38^{\circ}27'$, and then blue to $37^{\circ}41'$; larger drops were more difficult to manage. From measurements of fog-bows on Ben Nevis, J. McConnell had in 1890 already calculated the sizes of the respective drops. But some of these observations speak of a red outer margin, for which Pernter looked in vain, and which his calculations do not indicate; Crailheim-Gyllenskiöld (Swedish North Pole expedition, 1882) also describes the margin as of ochre colour. The classical white bows of Bouguer (1744) and of Scoresby (1821), however, do not fit into the theory at all, and were probably due, as the observers remarked, to ice-needles.

The general conclusions are interesting to meteorologists. The greater the drops, the more secondaries (spurious bows). A chief bow of intense pink and green (hardly any blue) indicates drops of diameters ranging from 1 to 2 mm.; intense red always speaks for big drops. Secondaries of green and violet (the blue is masked by contrast) without yellow, immediately joining the chief bow, correspond to drops of 0.5 mm., while five and more secondaries without white and without breaks mark drops of 0.1 mm. A partly white bow is produced by drops of 0.06 mm., and when the drops are still smaller, a real white bow with orange-yellow and blue margins is the result. The net result of these elaborate investigations will be to add a new interest to a natural phenomenon already endowed with many associations of magic and beauty.

EDUARD LINDEMANN AND OSCAR STUMPE.

THE last days of the old year witnessed the removal by death of two astronomers who have rendered valuable services in the respective positions in which they were situated, though not occupying prominent places in the history of the science. Both are mentioned by the authorities under whom they served with the utmost respect, and their loss is acknowledged with profound regret.

Dr. Eduard Lindemann, who died suddenly on December 21, was born in Nishni-Novgorod in 1842, and pursued his scientific studies in the Universities of Kasan and Dorpat. The latter University he left in 1868 to enter the observatory of Pulkova, wherein he filled the office of scientific secretary. In this capacity he had the management of the library, and the preparation of the second part of the "*Librorum in Bibliotheca Speculæ Pulkovensis contentorum Catalogus systematicus*" was entrusted to him, and very admirably did he fulfil the trust. The duties of his office did not permit him to take a great part in the astronomical observations there carried on; but his tastes led him to take great interest in the Zollner photometer, and the series of careful measures which he made with that instrument have led to his being regarded as an authority in its use. His paper on the "*Brilliance of Bessel's Stars in the Pleiades*," published in tome xxxii. of the *Mem. de l'Acad. Imp. des Sci. de S. Petersbourg*, is well known, and he has further used his measures to determine the scale of magnitude employed in the Bonn Durchmusterung.

The second astronomer whose death (at the early age of thirty-five) we have regretfully to mention is Dr. Oscar Stumpe, well known for his contribution on the motion of the solar system. Dr. Stumpe's early life appears to have been one of great hardship and a severe struggle against adverse circumstances. When ten years old he lost his father, but, in face of all difficulties, he determined to win his way to the Berlin University as a student of science. This he accomplished in 1883, though he had had occasionally in previous years to interchange the parts of student and teacher in order to obtain a livelihood and be enabled to continue his career. Even at Berlin, his studies of mathematics and astronomy were interrupted by his duties as a shorthand writer in the Government and Law Courts. From Berlin he went to Bonn, and became a teacher in a private institution. Here he appears to have prepared the heavy calculations which he afterwards incorporated in his inaugural dissertation on the Solar Motion. In this work, Dr. Stumpe based his computations on 1054 stars, whose annual proper motion exceeded $0''.16$ in the arc of a great circle. The peculiar feature in the treatment was the introduction of a term

depending upon a supposed orbital motion of the stars in the plane of the Milky Way. This term did not appear, however, to have a real existence. The stars were divided into four groups depending upon the amount of the annual proper motion, and the four solutions gave very accordant results in R.A. for the position of the apex of the solar system. The declination appeared less certain, but great confidence has been attached to the results of this particular investigation. Dr. Stumpe's talents as a computer have been generally recognised. He took some share in the calculations of the star places in the Bonn Zone Catalogue under Prof. Deichmüller, and afterwards, on repairing to Berlin in 1891, he was engaged in the preparation of the Zone Catalogue 15° — 20° declination. Since that time he has assisted Dr. Auwers in the many researches with which that astronomer has been connected, and who loses in him an able co-operator and a devoted assistant.

NOTES.

At the ordinary meeting of the Royal Society last week, Sir Nathaniel Lindley, Master of the Rolls, was balloted for and elected a Fellow under the special clause in the statutes which permits the admission of members of the Privy Council; and similarly, to-day it is proposed to ballot for Sir Herbert E. Maxwell. It may be recalled that Sir N. Lindley is a son of the late Dr. John Lindley, the famous botanist.

THE original lists of the subscribers to the Indian Section of the Pasteur International Memorial (British Division) have just been received from Surgeon-Major-General Cleghorn. On glancing down the columns where the profession of the donor is given, the first thing which strikes us is the very varied character of the generous contributors to this fund. We find, for example, members of the Indian Civil Service, the Indian Medical Service, officials in the opium department, in the salt department, forest officers and a number of native forest students, members of the legal profession (including a number of native pleaders), merchants (one of whom mentions having been a patient of Pasteur's), chaplains, medical and other missionaries, numbers of jailors and warders, an indigo planter, locomotive superintendents and assistants, the principal of a theological seminary at Insein in Burma, the superintendent of a Government lunatic asylum, civil apothecaries, bankers, revenue clerks, collectors and magistrates, numbers of "private gentlemen" (Indian), the Governor of Madras, the head-master of a missionary school, &c.; whilst the Army in India has also furnished a large contingent of subscribers. In one district we find a note saying that the inhabitants "are not willing to subscribe to the Pasteur Memorial, but will willingly subscribe towards the Pasteur Institute." The manner in which the fund has been supported in India not only reflects the greatest credit upon the subscribers, but also upon those who have so efficiently organised its collection.

At the Royal Institution last week, Prof. E. Ray Lankester, F.R.S., in commencing his course of eleven lectures on "The Simplest Living Things," remarked that though of late years it had become the custom to use the term physiology as meaning the study of the chemical and physical properties of living things in contradistinction to the study of their structure, yet fifty years ago it denoted their general study, and the Fullerian Professorship of Physiology—the chair to which Prof. Lankester has just been appointed—was intended for the furtherance of physiology in the broad sense now given to the term biology. It is proposed in a subsequent course to continue the consideration of the simplest living things by a detailed examination of the structure and activities of the different kinds bacteria, and to give an outline of the science of bacteriology.

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MR. CORNELIUS N. HOAGLAND has given to the Hoagland Biological Laboratory of Brooklyn a mortgage for 24,000 dollars.

ELECTRICITY is to be substituted for steam as the motive power of the elevated railroad system of New York City. Contracts for the new equipment have just been signed.

M. J. O. E. PERRIER, member of the section of anatomy and zoology of the Paris Academy of Sciences, has been elected *membre libre* of the Academy of Medicine, in succession to Dr. Magitot.

THE Council of the Sanitary Institute have accepted an invitation from the Lord Mayor and City Council of Birmingham to hold its seventeenth congress and exhibition in that city in September next.

AFTER sixteen years as professor of geography at the Royal University of Turin, Prof. Guido Cora has resigned his charge, in order to devote himself entirely to scientific researches in geography and related sciences. He has transferred his residence (and the direction of his periodical *Cosmos*) to Rome (Via Goito, 2).

THE death is announced of M. Bazin, the French engineer whose "roller-boat" has on several occasions been referred to in these columns.

THE unpublished manuscripts of the late Prof. Julius Sachs, of Würzburg, have, in accordance with his wish, been placed in the hands of Prof. Noll, of Brünna.

PROF. A. S. KIMBALL, for many years professor of physics in the Worcester Polytechnic Institute, and the author of a number of important papers on the subject of friction between sliding surfaces, as well as of other original contributions to physical science, died on December 2, 1897, after a long illness.

DR. DAWSON WILLIAMS, assistant editor of the *British Medical Journal*, who has been connected with the editorial department of the *Journal* for seventeen years, and has on many occasions discharged the duties of acting editor, has been appointed editor in succession to the late Mr. Ernest Hart. Mr. C. Louis Taylor, who has been sub-editor for the last eleven years, has been appointed assistant editor.

A CURIOUS incident in natural history is related by a correspondent of the *Aberdeen Journal* (January 22). While ferreting rabbits on the bank of a small stream, Mr. J. Robson, a gamekeeper who has for about sixty years been out with rod and gun between the Derwent and the Thurso rivers, states that on the ferret coming out of a hole and running up the edge of the stream, a trout leaped out of the water and fell on the gravel in front of the ferret. The ferret attacked the fish, and after considerable difficulty succeeded in capturing it. Mr. Robson sententiously adds: "I then creeled them both."

THE fifty-first annual general meeting of the Institution of Mechanical Engineers will be held in the rooms of the Institution of Civil Engineers, Westminster, on Thursday and Friday, February 10 and 11. The retiring president, Mr. E. Windsor Richards, will induct into the chair the president-elect, Mr. Samuel W. Johnson. The paper on "Mechanical Features of Electric Traction," by Mr. Philip Dawson, read at the last meeting, will be further discussed, and the following papers will be read and discussed, as far as time permits:—First Report to the Gas Engine Research Committee: description of apparatus and methods and preliminary results, by Prof. F. W. Burstall; steam laundry machinery, by Mr. Sidney Tebbutt.

THE death is announced from Halle of Dr. Ernst Ludwig Taschenberg, well known as an entomologist. Born in 1818, he was appointed in 1856 Director of the Zoological Museum at Halle. His entomological studies, begun after his connection